RESEARCH ARTICLE Indian Journal of Animal Research, Volume 57 Issue 5: 572-580 (May 2023)

Comparative Gross Anatomical and Biometrical Studies on Thyroid Gland of Buffalo, Sheep and Goat

Amit Poonia[1], Anuradha Gupta[1], Varinder Uppal[1]

10.18805/IJAR.B-4419

ABSTRACT

Background: The thyroid gland is vital endocrine gland which secretes three hormones *i.e.* thyroxin (T_4), triiodothyronine (T_3) and Calcitonin hormones. The thyroxin (T_4) and triiodothyronine (T_3) hormones are biologically active and are required for maintenance of normal levels of metabolic activity. The thyroid also produces calcitonin from the parafollicular cells which act directly on osteoclast to decrease the bone resorption which lower the blood calcium level. Deficient or excessive production of thyroid hormones may lead to serious pathological states with outward symptoms.

Methods: The gross anatomical and biometrical studies were conducted on thyroid gland of buffalo, sheep and goat (n=12) collected immediately after slaughtering from slaughter house and local meat shop. The weight of thyroid gland was measured by weighing balance, volume by water displacement method, length and width of lateral lobes and isthmus by calibrated scale and inelastic thread and thickness of lateral lobes and isthmus was measured by digital vernier calliper. The data was analysed statistically.

Result: The lateral lobes were roughly triangular in buffalo and elongated in sheep and oval in goat. The surfaces were granular and rough in buffalo but smooth in sheep and goat. It extended from thyroid cartilage to 2nd tracheal ring in buffalo, 1st to 6th tracheal ring in sheep and 1st to 7th tracheal ring in goat. The left lobe was larger than the right lobe in all the three species studied. The thyroid gland was biggest in buffalo followed by goat and smallest in sheep. The density of isthmus was more than the lobes in sheep and goat but not in buffalo.

Key words: Biometry, Buffalo, Goat, Gross anatomy, Sheep, Thyroid.

INTRODUCTION

Economy of rural India is dependent upon agriculture as well as animal husbandry. The livestock plays an important role in bread earning and fulfilment of daily household needs in rural India. Buffalo, sheep and goat are the important livestock of India and Punjab and contribute in milk, meat, wool and hide production. The buffalo plays a very important role in the Indian economy as it alone contributed 49% of the total milk produced in the country (Basic Animal Husbandry Statistics, 2019) and 12% of the world's milk production.The buffalo is well suited to hot and humid climates and muddy terrain due to its morphological and anatomical characteristics (Bhat, 2010 and Kumar and Pradhan, 2014).

India is the seventh largest producer of the wool and accounts for nearly 2 to 3% of the total world wool production (Indian Brand Equity Foundation, 2012). Sheep have an excellent ability to survive over a prolonged period of drought and semi-starvation and less prone to extreme weather conditions (Bhat and Arora, 2009). The improvement of the production of sheep is essential for the upliftment of agrarian economy as it is also considered as "mortgage lifter" in rural India. The goat rearing is more economical for poor people as it provides a better source of supplementary income and food security (Acharya and Kumar, 2013). Goat milk contributes 3% in the total milk production and 13.53% in meat production (Basic Animal Husbandry Statistics, 2019).

Thyroid gland is a reddish brown, highly vascular ductless endocrine gland. It is situated in the lower part of the neck. It is present in all mammals and performs many physiological functions. Thyroid gland varies greatly in different mammals. The gland consists of two separate lobes connected by an isthmus (Doley and Chakravorty, 2016). The thyroid gland is the primary endocrine organ responsible for the regulation of metabolism and plays an important role in growth and reproduction (Hulbert and Augee, 1982 and Capen, 2007). The thyroid gland is vital endocrine gland which secretes three hormones *i.e.* thyroxin (T_4), triiodothyronine (T_3) and Calcitonin hormones. The thyroxin (T_4) and triiodothyronine (T_3) hormones are biologically active and are required for maintenance of normal levels of metabolic activity (Janini *et al.,* 1993 and Krassas, 2000).

Gross anatomical studies on the thyroid gland have been reported in buffalo (Jain *et al.,* 1984 and Policarpio *et al.,* 1997),

[1]Department of Veterinary Anatomy, College of Veterinary Science, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana-141 004, Punjab, India.

Corresponding Author: Amit Poonia, Department of Veterinary Anatomy, College of Veterinary Science, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana-141 004, Punjab, India. Email: amitpoonia263@gmail.com

How to cite this article: Poonia, A., Gupta, A. and Uppal, V. (2023). Comparative Gross Anatomical and Biometrical Studies on Thyroid Gland of Buffalo, Sheep and Goat. Indian Journal of Animal Research. 57(5): 572-580. doi: 10.18805/IJAR.B-4419.

Submitted: 05-02-2021 **Accepted:** 20-09-2021 **Online:** 27-10-2021

sheep (Bhardwaj *et al.,* 2006 and Ali *et al.,* 2015), goat (Roy *et al.,* 1975; Bhardwaj *et al.,* 2006; Joshi, 2016; Dar *et al.,* 2018 and Menaka *et al*., 2019), cattle (Kumar *et al.,* 2018) and camel (Ahmadpanahi and Yousefi, 2012). Scanty work has been reported on comparative gross anatomical and biometrical studies of thyroid gland of buffalo, sheep and goat. Keeping in view the scarcity of literature, the present study was planned to achieve baseline data that could be utilized to study the physiological importance and to diagnose various diseases of thyroid gland.

MATERIALS AND METHODS

The gross anatomical and biometrical studies were conducted on thyroid gland of adult buffalo, sheep and goat (n=12 each) collected from slaughter house and local meat shop. The gross anatomical studies were conducted on the thyroid gland immediately after slaughtering. The thyroid gland was collected by separating it from the cranial part of trachea and related structures and cleaned properly. After gross anatomical studies, the thyroid gland was subjected to biometrical analysis. The weight of thyroid gland was measured by weighing balance, volume by water displacement method, length and width of lateral lobes and isthmus by calibrated scale and inelastic thread and thickness of lateral lobes and isthmus was measured by digital vernier calliper. The density of thyroid gland was measured by dividing weight by volume.

RESULTS AND DISCUSSION

Gross morphology

The thyroid gland was comprised of two lateral lobes i.e. left and right joined by a thin strand of isthmus in buffalo (Fig 1 and 2), sheep (Fig 3 and 4) and goat (Fig 5 and 6). Similar findings have been reported by Jain *et al.,* (1984) and Policarpio *et al.* (1997) in buffalo, Ali *et al.* (2015) and Kumar *et al.* (2018) in sheep and Bhardwaj *et al.* (2006), Joshi (2016); Dar *et al.* (2018) and Menaka *et al.* (2019) in goat.

Location

The lateral lobes were roughly triangular (Fig 2 and 8) in buffalo except a few (3) which had quadrangular left lobe. It extended from caudal aspect of thyroid cartilage of larynx up to 2nd tracheal ring on lateral aspect (Fig 7). Similar findings have been reported by Jain *et al.* (1984) in buffalo and Kumar *et al.* (2018) in ox whereas Policarpio *et al.* (1997) found that the lateral lobes extended up to 3rd tracheal ring in Philippine carabao.

In sheep, both the lobes were elongated in shape (Fig 4 and 10). The gland was located on the dorsolateral aspect of the trachea posterior to the larynx (Fig 3), extended obliquely from 1st tracheal ring to 5th to 6th tracheal ring (Fig 9) and converged caudally to medial aspect. The present findings are in accordance to observations of Jain *et al.* (1984). However, Bhardwaj *et al.* (2006) reported that the gland extended from posterior extremity of larynx to 5th to 7th tracheal ring in sheep.

The lateral lobes were oval in shape (Fig 4 and 12) and placed obliquely extending from 1st to 6th - 7th tracheal ring (Fig 3 and 11) but upto 8th tracheal ring in some specimens in goat. Similar findings have been reported by Joshi (2016), Dar *et al.* (2018) and Menaka *et al.* (2019) in goat.



Fig 1: Ventral view of thyroid gland (TG) and isthmus of buffalo with larynx (L) and trachea (T).



Fig 2: Thyroid gland (TG) and isthmus (I) of buffalo.



Fig 3: Lateral view of thyroid gland (TG) of sheep with trachea (T) and larynx (L).

The isthmus was located from 1st to 2nd tracheal ring in buffalo (Fig 1 and 7) which was in consonance to the findings of Jain *et al.* (1984) whereas Maala and Reynoso (1997) observed that the isthmus was lodged in the groove between the cricoid cartilage and first tracheal ring in Philippine carabao.

The isthmus was found from 4th to 6th tracheal ring in sheep (Fig 3 and 9). The double band of isthmus was found in one of the sheep studied. In goat, the level of isthmus was from 5th to 6th tracheal rings (Fig 5 and 11) which were in accordance to the findings of Joshi (2016) and Dar *et al.* (2018). The two specimen of goat had very wide band of isthmus.

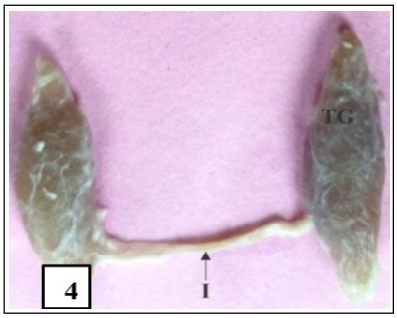


Fig 4: Thyroid gland (TG) and isthmus (I) of sheep.



Fig 5: Lateral view of thyroid gland (TG) of goat along with trachea (T) and larynx (L).

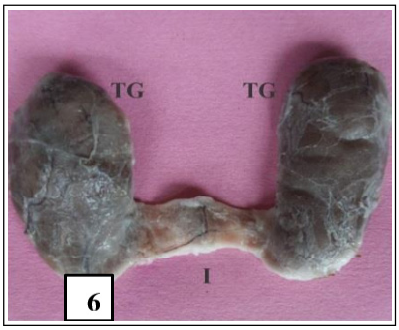


Fig 6: Thyroid gland (TG) and isthmus (I) of goat.

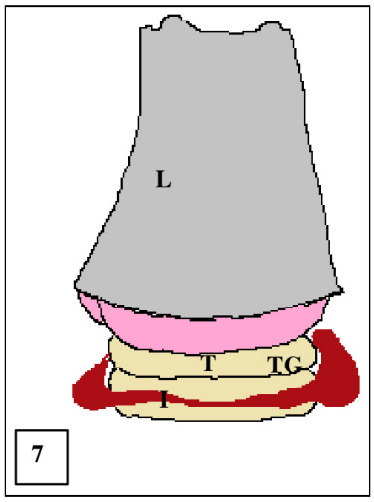


Fig 7: Ventral view of thyroid gland (TG) and isthmus of buffalo with larynx (L) and trachea (T).

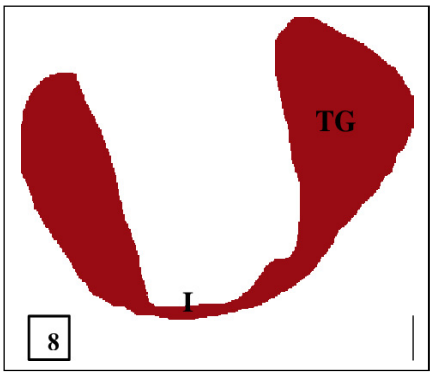


Fig 8: Thyroid gland (TG) and isthmus (I) of buffalo.

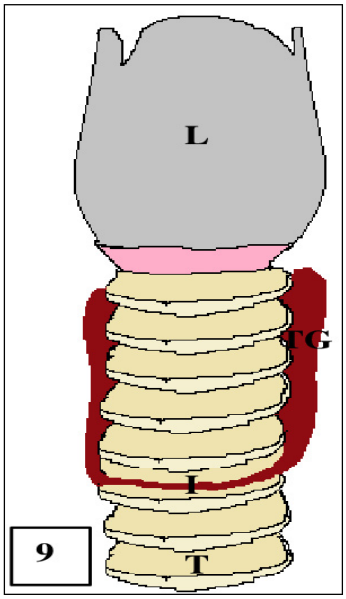


Fig 9: Lateral view of thyroid gland (TG) of sheep with trachea (T) and larynx (L).

Appearances

Both the surfaces (lateral and medial) of lobes were granular, rough and covered by capsule in buffalo, sheep and goat. The lobules were visible from the surface in all the animals studied. The left lobe was larger than the right lobe in buffalo, sheep and goat. The thyroid gland was biggest in buffalo followed by goat and smallest in sheep.

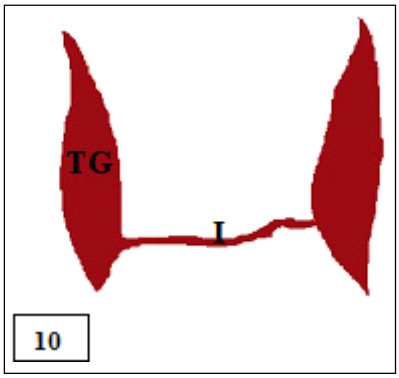


Fig 10: Thyroid gland (TG) and isthmus (I) of sheep.

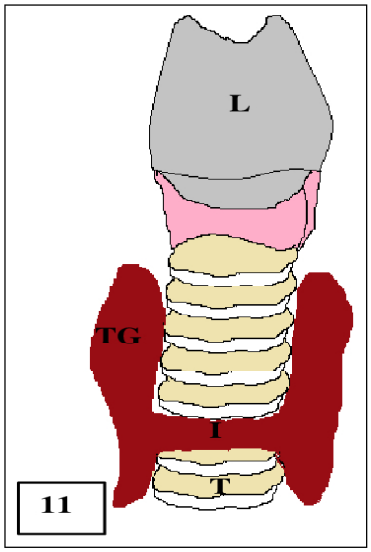


Fig 11: Lateral view of thyroid gland (TG) of goat along with trachea (T) and larynx (L).

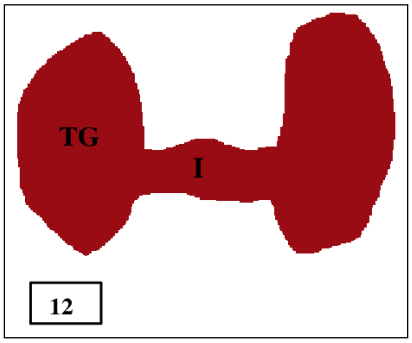


Fig 12: Thyroid gland (TG) and isthmus (I) of goat.

Lateral surface of both the lobes was convex in buffalo, sheep and goat while the medial surface was flat in buffalo and concave in sheep and goat. The medial surface of thyroid gland was related to cricoid and thyroid cartilage of larynx in buffalo whereas trachea in sheep and goat. Similar findings have been reported by Jain *et al.* (1984) in buffalo and Bhardwaj *et al.* (2006) in sheep.

Anterior and dorsal borders were convex and continuous, posterior border was straight and ventral border was thin and continued as isthmus in buffalo. Anterior and posterior borders were convex and dorsal and ventral borders were pointed and isthmus continued slightly above the posterior border towards ventral aspect in sheep. Anterior, dorsal and posterior borders were convex and continuous and ventral border was straight and isthmus continued from posterior border towards ventral aspect in goat. The colour of lateral lobes was reddish brown in buffalo and goat and pale brown in sheep. Similarly, Bhardwaj *et al.* (2006) noticed that lateral lobes were joined to each other by the isthmus at caudal poles in goat whereas in sheep, the lobes were connected about half cm above the posterior end.

The isthmus was pale in colour in buffalo and sheep but light brown in goat. The isthmus was wider and flat near its junction with the lobe and became narrower in the middle in buffalo. The isthmus was in the form of wide band which was wider at the junction with lobes in goat. Whereas, the isthmus was flat and uniform in width throughout its length in sheep. Menaka *et al.* (2019) observed that isthmus was very thin and fibrous strand which connected the caudal poles of the lobes in goat.

Biometry

Length

The length of left lobe of thyroid gland varied from 4.1 to 7.8 cm with the mean of 5.18±0.35 cm in buffalo, 3.2 to 5.0 cm with mean of 4.10±0.19 cm in sheep and 3 to 5.6 cm with mean of 4.30±0.22 cm in goat (Table 1 and Graph 1). Similar findings have been reported by Jain *et al.* (1984) in buffalo and Bhardwaj *et al.* (2006) in goat and sheep and Choudhary and Doley (2017) and Dar *et al.* (2018) in goat. Whereas, Doley and Chakravorty (2016) recorded average length of left lobe as 1.41 cm, Joshi (2016) measured the length of left lobe as 2.38±0.019 cmand Menaka *et al.* (2019) recorded the length of left lobe as 22.19±0.42 mm in goat. However, Maala and Reynoso (1997) measured the length of lobes as 36-45 mm in Philippine carabao. There was significant difference in length of left lobe ($p<0.05$) in buffalo than sheep and goat but no significant difference ($p>0.05$) was found between sheep and goat (Table 1).

The length of right lobe of thyroid gland varied from 3.4 to 8.0 cm with the mean of 4.86±0.35 cm in buffalo, 3.2 to 4.55 cm with mean of 3.79±0.19 cm in sheep and 3.2 to 4.6 cm with mean of 3.92±0.16 cm in goat (Table 1 and Graph 1). Similar findings have been reported by Jain *et al.* (1984) in buffalo and Bhardwaj *et al.* (2006) in goat and sheep and

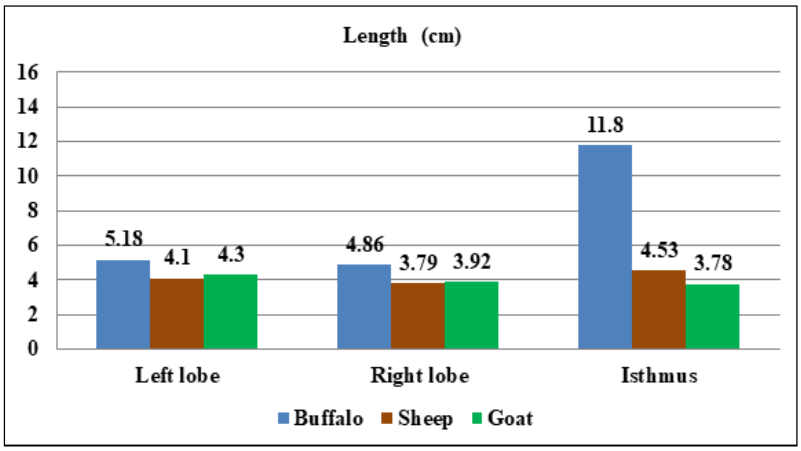
Choudhary and Doley (2017) and Dar *et al.* (2018) in goat. Whereas, Doley and Chakravorty (2016) recorded average length of right lobe as 1.46 cm, Joshi (2016) measured length of right lobe as 3.08±0.054 cm and Menaka *et al.* (2019) recorded length of right lobe as 22.19±0.42 mm in goat. There was significant difference in length of right lobe ($p<0.01$) in buffalo than sheep and goat but no significant difference ($p>0.05$) was found between sheep and goat. The left lobe was longer than the right lobe in buffalo, sheep and goat.

The length of isthmus of thyroid gland varied from 10 to 15 cm with the mean of 11.8±0.57 cm in buffalo, 4.0 to 5.3 cm with mean of 4.53±0.16 cm in sheep and 2.1 to 4.8 cm with mean of 3.78±0.20 cm in goat (Table 1 and Graph 1). Joshi (2016) measured the mean length of isthmus 2.12±0.129 cm in goat. There was significant difference in length of isthmus ($p<0.001$) in buffalo than sheep and goat but no significant difference ($p>0.05$) was found between sheep and goat (Table 1).

Table 1: Biometrical data on various parameters of thyroid gland of buffalo, sheep and goat.

Parameter		Species			P-value
		Buffalo	Sheep	Goat	
Length (cm)	Left lobe	5.18±0.35^{a}	4.10±0.19^{b}	4.30±0.22^{b}	S ($p<0.05$)
	Right lobe	4.86±0.35^{a}	3.79±0.19^{b}	3.92±0.16^{b}	S ($p<0.01$)
	Isthmus	11.80±0.57^{a}	4.53±0.16^{b}	3.78±0.20^{b}	S ($p<0.001$)
Width (cm)	Left lobe	4.26±0.21^{a}	1.57±0.13^{b}	2.08±0.11^{c}	S ($p<0.001$)
	Right lobe	3.95±0.23^{a}	1.45±0.09^{b}	2.07±0.1^{c}	S ($p<0.001$)
	Isthmus	0.85±0.07	0.55±0.07	0.85±0.16	NS
Thickness (cm)	Left lobe	1.22±0.05^{a}	0.58±0.03^{b}	0.73±0.05^{c}	S ($p<0.001$)
	Right lobe	1.14±0.04^{a}	0.55±0.03^{b}	0.73±0.05^{c}	S ($p<0.001$)
	Isthmus	0.41±0.02^{a}	0.05±0.001^{b}	0.13±0.01^{c}	S ($p<0.001$)
Weight (g)	Whole gland	19.23±1.93^{a}	2.48±0.16^{b}	3.64±0.51^{b}	S ($p<0.001$)
	Left lobe	9.64±0.71^{a}	1.27±0.09^{b}	1.74±0.25^{b}	S ($p<0.001$)
	Right lobe	8.03±1.09^{a}	1.06±0.07^{b}	1.63±0.23^{b}	S ($p<0.001$)
	Isthmus	1.55±0.22^{a}	0.15±0.02^{b}	0.27±0.04^{b}	S ($p<0.001$)
Volume (cc)	Whole gland	19.81±2.02^{a}	2.40±0.15^{b}	3.61±0.50^{b}	S ($p<0.001$)
	Left lobe	9.87±0.76^{a}	1.25±0.08^{b}	1.74±0.25^{b}	S ($p<0.001$)
	Right lobe	8.29±1.13^{a}	1.03±0.07^{b}	1.63±0.23^{b}	S ($p<0.001$)
	Isthmus	1.69±0.25^{a}	0.12±0.01^{b}	0.25±0.04^{b}	S ($p<0.001$)
Density (g/cc)	Whole gland	0.97±0.008^{b}	1.04±0.011^{a}	1.007±0.016^{ab}	S ($p<0.01$)
	Left lobe	0.98±0.01	1.02±0.009	1.00±0.017	NS
	Right lobe	0.97±0.013^{b}	1.03±0.02^{a}	1.00±0.018^{ab}	NS
	Isthmus	0.93±0.026^{b}	1.22±0.19^{a}	1.099±0.045^{ab}	NS

Means with different small letters superscript in the same row differed significantly ($p<0.05$).



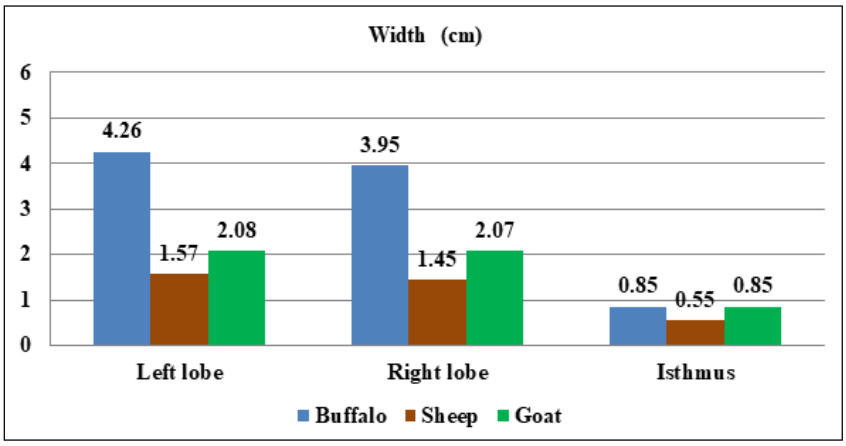
Graph 1: Length of left lobe, right lobe and isthmus of buffalo, sheep and goat.

Width

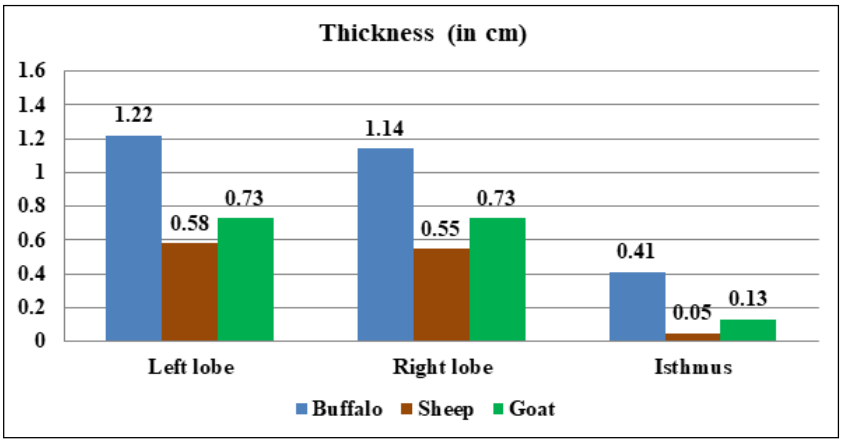
The width of left lobe of thyroid gland varied from 3.8 to 5.5 cm with the mean of 4.26±0.21 cm in buffalo, 0.9 to 2.4 cm with mean of 1.57±0.13 cm in sheep and 1.6 to 2.8 cm with mean of 2.08±0.11 cm in goat (Table 1 and Graph 2). Similar findings were reported by Jain *et al.* (1984) in buffalo, Bhardwaj *et al.* (2006) in sheep and Choudhary and Doley (2017) in goat. Whereas, Maala and Reynoso (1997) noticed that width of lateral lobes varied from 26 to 37 mm in thyroid gland of Philippine carabao. Bhardwaj *et al.* (2006) found the mean width of left lobe of thyroid gland as 1.30±0.05 cm, Doley and Chakravorty (2016) measured width of left lobe as 0.52 cm and Joshi recorded width of left lobe 0.85±0.027 cm in goat. There was significant difference in width of left lobe ($p<0.001$) among buffalo, sheep and goat.

The width of right lobe of thyroid gland varied from 3.0 to 5.6 cm with the mean of 3.95±0.23 cm in buffalo, 1.1 to 2.1 cm with mean of 1.45±0.09 cm in sheep and 1.6 to 2.7 cm with mean of 2.07±0.1 cm in goat (Table 1; Graph 2). Similar findings were reported by Jain *et al.* (1984), buffalo, sheep and goat, respectively; Bhardwaj *et al.* (2006) in sheep and Choudhary and Doley (2017) in goat. Whereas, Maala and Reynoso (1997) noticed that width of lateral lobes varied from 26 to 37 mm in thyroid gland of Philippine carabao. Bhardwaj *et al.* (2006) found the mean width of right lobe of thyroid gland as 1.30±0.05 cm, Doley and Chakravorty (2016) recorded 0.53 cm and Joshi (2016) recorded 1.06±0.013 cm respectively in goat. There was significant difference in width of right lobe ($p<0.001$) among buffalo, sheep and goat.

The width of isthmus of thyroid gland varied from 0.5 to 1.4 cm with the mean of 0.85±0.07 cm in buffalo, 0.26 to 1.0 cm with mean of 0.55±0.07 cm in sheep and 0.25 to 2.1 cm with mean of 0.85±0.16 cm in goat (Table 1; Graph 2). Similar findings were recorded by Maala and Reynoso (1997) in Philippine carabao and Joshi (2016) in goat. There was no significant difference ($p>0.05$) found in width of isthmus among buffalo, sheep and goat.



Graph 2: Width of left lobe, right lobe and isthmus of buffalo, sheep and goat.



Graph 3: Thickness of left lobe, right lobe and isthmus of buffalo, sheep and goat.

Thickness

The thickness of left lobe of thyroid gland varied from 0.9 to 1.6 cm with the mean of 1.22±0.05 cm in buffalo, 0.42 to 0.7 cm with mean of 0.58±0.03 cm in sheep and 0.51 to 0.87 cm with mean of 0.73±0.05 cm in goat (Table 1 and Graph 3). Similar findings have been reported earlier by Jain *et al.* (1984) in buffalo, Bhardwaj *et al.* (2006) in sheep and goat; Joshi (2016) and Menaka *et al.* (2019) in goat. Whereas, Maala and Reynoso (1997) recorded the thickness of lateral lobes as 9-12 mm in Philippine carabao and Doley and Chakravorty (2016) recorded thickness of left lobe as 0.41 cm in goat.

The thickness of right lobe of thyroid gland varied from 0.9 to 1.5 cm with the mean of 1.14±0.04 cm in buffalo, 0.41 to 0.7 cm with mean of 0.55±0.03 cm in sheep and 0.4 to 0.91 cm with mean of 0.73±0.05 cm in goat (Table 1 and Graph 3). Similar findings have been reported by Jain *et al.* (1984) in buffalo, Bhardwaj *et al.* (2006) in sheep and goat and Joshi (2016) and Menaka *et al.* (2019) in goat. Doley and Chakravorty (2016) recorded thickness of right lobe as 0.42 cm in goat.There was significant difference in thickness of left and right lobe ($p<0.001$) among buffalo, sheep and goat (Table 1).

The thickness of isthmus of thyroid gland varied from 0.3 to 1.6 cm with the mean of 0.41 ±0.02 cm in buffalo, 0.04 to 0.06 cm with mean of 0.05±0.001 cm in sheep and 0.1 to 0.23 cm with mean of 0.13±0.01 cm in goat (Table 1; Graph 3). Whereas, Maala and Reynoso (1997) observed that the thickness of isthmus as 2-5 mm in Philippine carabao. There was significant difference in thickness of isthmus ($p<0.001$) among buffalo, sheep and goat.

Weight

The weight of thyroid gland varied from 13.24 to 33.0 g with the mean of 19.23±1.93 g in buffalo, 1.74 to 3.52 g with mean of 2.48±0.16 g in sheep and 1.85 to 7.8 g with mean of 3.64±0.51 g in goat (Table 1 and Graph 4). Similar findings were reported by Jain *et al.* (1984) in buffalo and Menaka *et al.* (2019) in goat. Doley and Chakravorty (2016) recorded the average weight of gland as 6.93 g in goat. There was significant difference in weight of gland ($p<0.001$) in buffalo than sheep and goat but no significant difference ($p>0.05$) was found between sheep and goat.

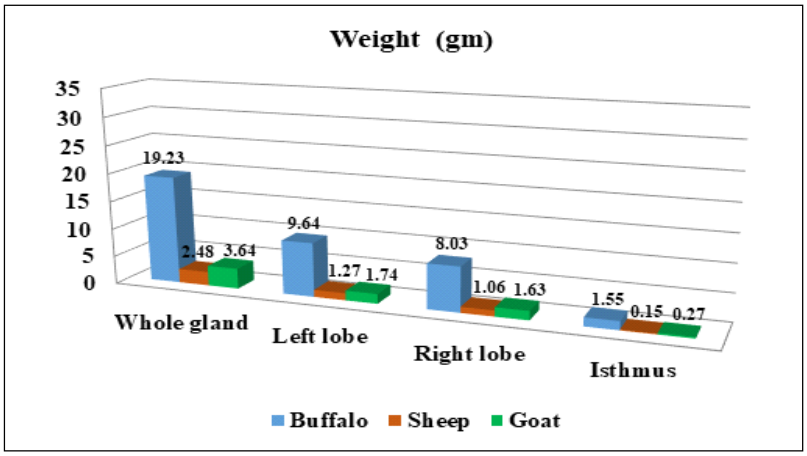
The weight of left lobe of thyroid gland varied from 7.75 to 14.5 g with the mean of 9.64±0.71 g in buffalo, 0.88 to 1.88 g with mean of 1.27±0.09 g in sheep and 0.79 to 3.76 g with mean of 1.74±0.25 g in goat (Table 1 and Graph 4). Similar findings have been reported by Bhardwaj *et al.* (2006) in sheep and goat and Joshi (2016) in goat. Whereas, Choudhary and Doley (2017) found that the mean weight of the left lobe was 4.98±0.03 g in goat.

The weight of right lobe of thyroid gland varied from 4.48 to 15.7 g with the mean of 8.03±1.09 g in buffalo, 0.72 to 1.51 g with mean of 1.06±0.07 g in sheep and 0.8 to 3.54 g with mean of 1.63±0.23 g in goat (Table 1 and Graph 4). Similar findings have been reported by Bhardwaj *et al.* (2006) in sheep and goat and Joshi (2016) in goat. Whereas, Choudhary and Doley (2017) found that the mean weight of the right lobe was 5.07±0.04 g. There was significant difference in weight of left and right lobe ($p<0.001$) in buffalo than sheep and goat but no significant difference ($p>0.05$) was found between sheep and goat.

The weight of isthmus of thyroid gland varied from 0.6 to 2.85 g with the mean of 1.55±0.22 g in buffalo, 0.1 to 0.32 g with mean of 0.15±0.02 g in sheep and 0.1 to 0.5 g with mean of 0.27±0.04 g in goat (Table 1 and Graph 4). There was significant difference in weight of isthmus ($p<0.001$) in buffalo than sheep and goat but no significant difference ($p>0.05$) was found between sheep and goat.

Volume

The volume of whole thyroid gland varied from 13.0 to 34.0 cc with the mean of 19.81±2.02 cc in buffalo, 1.7 to 3.4 cc with mean of 2.40±0.15 cc in sheep and 2.0 to 7.6 cc with mean of 3.61±0.50 cc in goat (Table 1 and Graph 5). Whereas, Menaka *et al.* (2019) measured the volume as



Graph 4: Weight of whole gland, left lobe, right lobe and isthmus of buffalo, sheep and goat.

1.38±0.06 cc in goat. There was significant difference in volume of gland ($p<0.001$) in buffalo than sheep and goat but no significant difference ($p>0.05$) was found between sheep and goat.

The volume of left lobe of thyroid gland varied from 7.5 to 15 cc with the mean of 9.87±0.76 cc in buffalo, 0.9 to 1.8 cc with mean of 1.25±0.08 cc in sheep and 0.9 to 3.7 cc with mean of 1.74±0.25 cc in goat (Table 1 and Graph 5). Similar findings were reported by Bhardwaj *et al.* (2006) in sheep and goat and Joshi (2016) in goat. Whereas, Dar *et al.* (2018) found that the volume of left lobe varied from 1.20 to 6.20 cc in different age groups of Bakerwali goat.

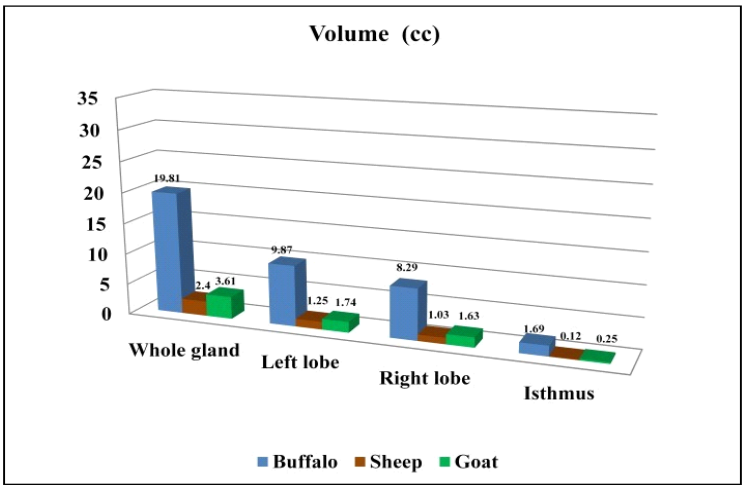
The volume of right lobe of thyroid gland varied from 4.8 to 16 cc with the mean of 8.29±1.13 cc in buffalo, 0.7 to 1.4 cc with mean of 1.03±0.07 cc in sheep and 0.8 to 3.5 cc with mean of 1.63±0.23 cc in goat (Table 1 and Graph 5). Similar findings were reported by Bhardwaj *et al.* (2006) in sheep and goat and Joshi (2016) in goat. Whereas, Dar *et al.* (2018) found that the volume of right lobe varied from 1.00 to 5.50 cc in different age groups of goat. There was significant difference in volume of left and right lobe ($p<0.001$) in buffalo than sheep and goat but no significant difference ($p>0.05$) was found between sheep and goat.

The volume of isthmus thyroid gland varied from 0.6 to 3.5 cc with the mean of 1.69±0.25 cc in buffalo, 0.1 to 0.2 cc with mean of 0.12±0.01 cc in sheep and 0.1 to 0.5 cc with mean of 0.25±0.04 cc in goat (Table 1 and Graph 5). There was significant difference in volume of isthmus ($p<0.001$) in buffalo than sheep and goat but no significant difference ($p>0.05$) was found between sheep and goat.

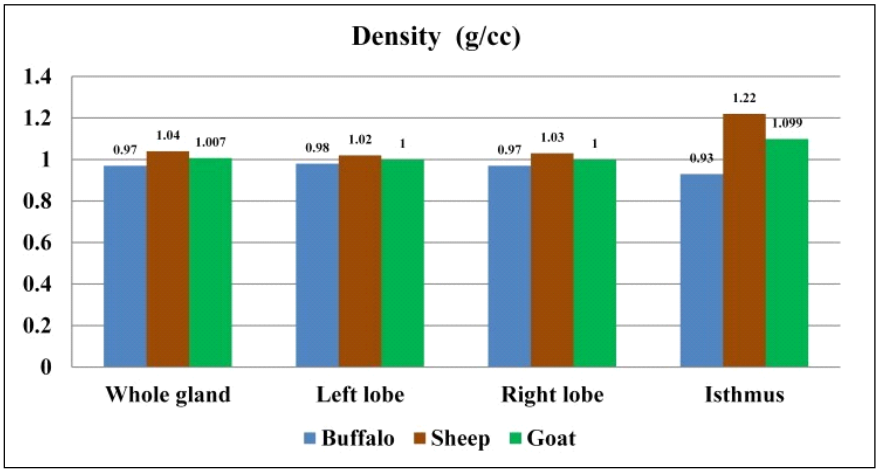
Density

The mean density of thyroid gland was 0.97±0.008 g/cc in buffalo, 1.04±0.011g/cc in sheep and 1.007±0.016 g/cc in goat (Table 1 and Graph 6). There was significant difference in density of gland ($p<0.01$) in buffalo than sheep but not with goat.

The mean density of left lobe of thyroid gland was 0.98±0.01 g/cc in buffalo, 1.02±0.009 g/cc in sheep and



Graph 5: Volume of whole gland, left lobe, right lobe and isthmus of buffalo, sheep and goat.



Graph 6: Density of whole gland, left lobe, right lobe and isthmus of buffalo, sheep and goat.

Table 2: Relationship of weight with other parameters of Thyroid gland of buffalo, sheep and goat.

Biometry parameters	Weight (correlation coefficient, 'r')		
	Buffalo	Goat	Sheep
Length	-0.246	0.390*	0.179
Width	0.601**	0.529**	0.670**
Thickness	0.627**	0.578**	0.584**

**Correlation is significant at the 0.01 level (2-tailed).

*Correlation is significant at the 0.05 level (2-tailed).

1.00±0.017 g/cc in goat (Table 1 and Graph 6). There was no significant ($p>0.05$) difference in density of left lobe, right lobe and isthmus in buffalo, sheep and goat. The mean density of right lobe of thyroid gland was 0.97±0.013 g/cc in buffalo, 1.03±0.02 g/cc in sheep and 1.00±0.018 g/cc in goat (Table 1 and Graph 6). There was no significant ($p>0.05$) difference in density of left lobe, right lobe and isthmus in buffalo, sheep and goat.

The mean density of isthmus of thyroid gland was 0.93±0.026 g/cc in buffalo, 1.22±0.19 g/cc in sheep and 1.099±0.045 g/cc in goat (Table 1 and Graph 6). There was no significant ($p>0.05$) difference in density of left lobe, right lobe and isthmus in buffalo, sheep and goat. The density of isthmus was more than the lobes in sheep and goat but not in buffalo. This may be due to the reason that the isthmus of buffalo contained more glandular tissue and less connective tissue as compared to sheep and goat. The isthmus of sheep and goat was comparatively more fibrous than buffalo.

The weight was not co-related with length in buffalo and sheep but was positively co-related ($p<0.01$) in goat. The weight was positively co-related ($p<0.05$) with width and thickness in buffalo, sheep and goat (Table 2).

CONCLUSION

The thyroid gland was biggest in buffalo followed by goat and smallest in sheep. All the biometrical parameters of thyroid gland were highest in buffalo followed by goat and sheep. The density of isthmus was more than the lobes in sheep and goat but not in buffalo.

REFERENCES

Acharya, R.M. and Kumar, P. (2013). Goat Production in India.1st Edn. IBDC Publishers, Lucknow, U.P, India. pp 1-22.

Ahmadpanahi, S.J. and Yousefi, M.H. (2012). Anatomical and histological study on thyroid gland in one humped camel (*Camelus dromedarious*). Journal of Veterinary Research. 67(3): 273-278.

Ali, M.A., Sadoon, A.H., Da'aj, S.A. and Ali, S.A. (2015). Anatomical and histological study of thyroid gland in local Iraqian sheeps. Journal of International Academic Research for Multidisciplinary. 3(3): 195-201.

Basic Animal Husbandry Statisitics (2019). Ministry of Fisheries, Animal Husbandry and Dairying, Krishi Bhawan, Government of India, New Delhi.

Bhardwaj, R.L., Rajput, R., Pathak, V. and Thakur, K. (2006). Comparative anatomy of the thyroid gland of small ruminants. Indian Journal of Animal Sciences. 76(1): 46-47.

Bhat, P.N. and Arora, C.L. (2009). Sheep Production. Stadium Press (India) Pvt. Ltd. pp 1-13.

Bhat, P.N. (2010). Buffalo Production. Stadium Press (India) Pvt. Ltd. pp 1-25.

Capen, C.C. (2004). Pathophysiology of the Thyroid Gland. In: Veterinary Pathophysiology. [Dunlop, R.H. and Malbert, C. (Eds)]. Blackwell Publishing Ltd: Oxford. pp. 456-457.

Choudhary, O.P. and Doley, P.J. (2017). Histomorphological and scanning electron microscopic studies of thyroid gland in jamunapari goats. Indian Journal of Small Ruminants. 23(1): 120-122.

Dar, Y., Suri, S., Sarma, K. and Sasan, J.S. (2018). Gross morphological and biometrical studies on the thyroid gland in Bakerwali goat (*Capra hircus*). Applied Biological Research. 20(2): 209-214.

Doley, A. and Chakravorty, M. (2016). A comparative study of thyroid gland in some mammals. Journal Evid. Based Med Healthc. 3(63): 3448-3451.

Hulbert, A.J. and Augee, M.L. (1982). A comparative study of thyroid function in monotreme, marsupial and eutherian mammals. Physiological Zoology. 55: 220-228.

Indian Brand Equity Foundation. (2012). Wool Industry in India. Available at: https://www.ibef.org/pages/32331.

Jain, R.K., Singh, Y. and Kumar, S. (1984).Comparative anatomy of the thyroid gland in ruminants. Haryana Veterinarian. 23(2): 77-82.

Janini, E.A., Ulisse, S., Piersanti, D., Carosa, E., Muzi, P.L.J. and D' Armiento, M. (1993). Early thyroid hormone treatment in rats increases testis size and germ cell number. Endocrinology. 132(6): 2726-2728.

Joshi, S. (2016). Gross and histological studies on the thyroid gland of goat. Ph.D. Dissertation. Rajasthan University of Veterinary and Animal Sciences, Bikaner, Rajasthan.

Krassas, G.E. (2000). Thyroid disease and female reproduction. Fertility Sterility. 74(6): 1063-1070.

Kumar, A.T. and Pradhan, S. (2014). Handbook of Animal Husbandry. 4th edn. Indian Council of Agricultural Research, New Delhi.

Kumar, D., Vaish, R., Pandey, Y., Gupta, N., Umeel and Kumar, P. (2018). Thyroid gland: An anatomical perspective. Journal of Entomology and Zoology Studies. 6(4): 1400-1405.

Maala, C.P. and Reynoso, L.V. (1997). Some histological and histochemical features of thr thyroid gland and its isthmus in the Philipine carabao (*Bubalus bubalis*). Philippine Journal of Veterinary and Animal Sciences. 23(1-2): 45-60.

Menaka, R., Chaurasia, S. and Puri, G. (2019). Gross morphometerical study of thyroid glands in surti goat (*Capra hircus*). Veterinary Research International. 7(1): 21-25.

Policarpio, J.F., De Ocampo, G.D. and Sarabia, A.S. (1997). Biometry and histology of the thyroid gland of Philippine carabao (*Bubalus bubalis* L.) and its crossbred. http://www.uplb.edu.ph.

Roy, K.S., Saigal, R.P., Nanda, B.S. (1975). Gross histomorphological and histochemical changes in thyroid gland of goat with age. Anatomischer Anzeiger. 137: 479-485.